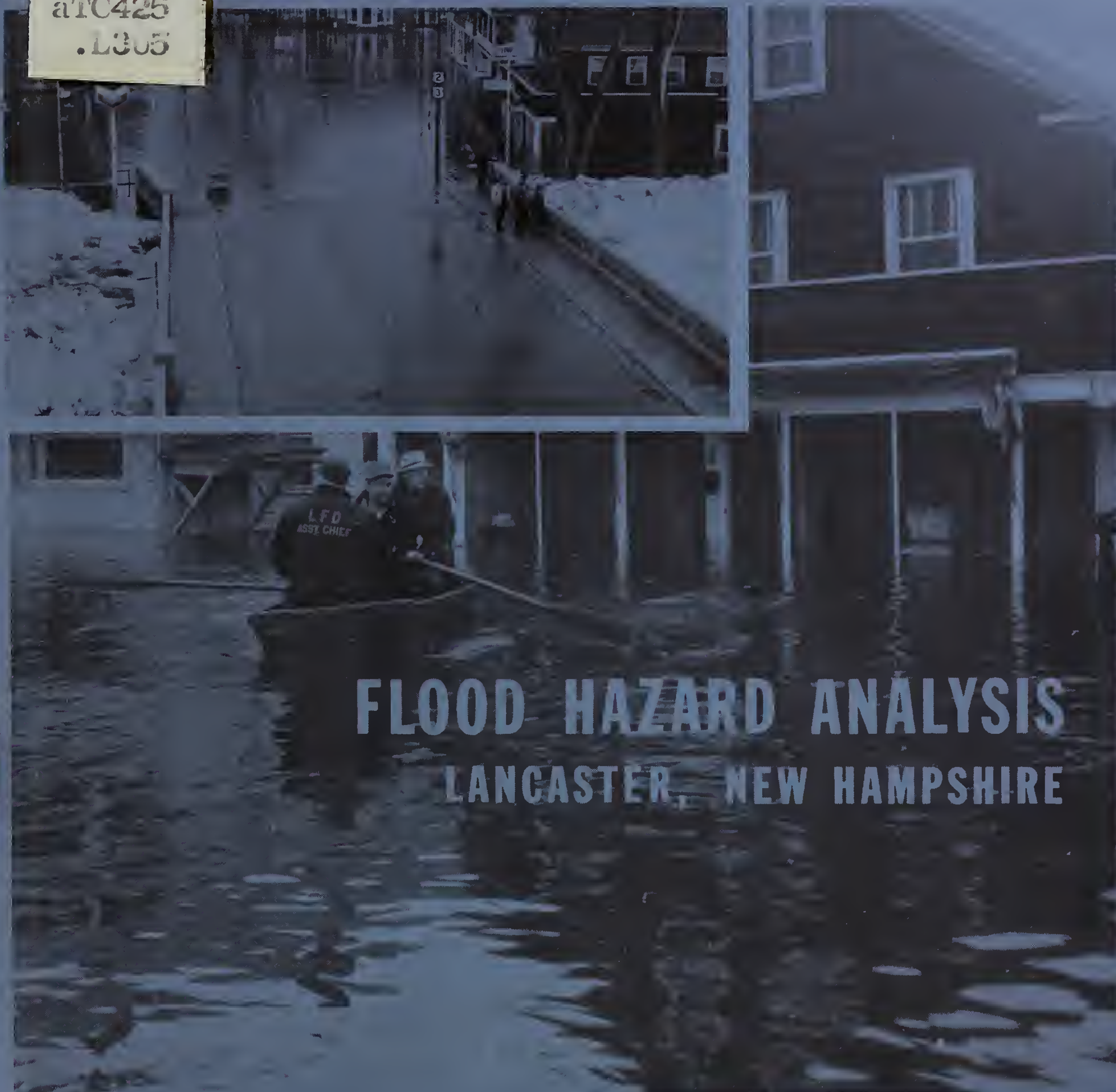


# FLOOD HAZARD ANALYSIS
## LANCASTER, NEW HAMPSHIRE

conducted by the
United States Department of Agriculture
Soil Conservation Service
in cooperation with
State of New Hampshire
Office of Comprehensive Planning

SEPTEMBER - 1973

COVER PICTURES: Two views of March 1968 ice jam flood on Main Street, Lancaster, New Hampshire.

Photos by Bonnie Lee Studio

# FLOOD HAZARD ANALYSIS

# LANCASTER, NEW HAMPSHIRE

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September 1973

# FOREWORD

The Lancaster Flood Hazard Analysis was conducted by the United States Department of Agriculture, Soil Conservation Service, in cooperation with the State of New Hampshire Office of Comprehensive Planning, under the authority of Section 6, PL 83-566, in accordance with Recommendation 9(c) of House Document No. 465, 89th Congress, and Executive Order 11296. The study was initiated in August of 1971, with field data obtained in September, October and November of that year. Calculations and mapping were prepared during the summer of 1972.

The purpose of the study is to encourage awareness of local flood plain areas and to serve as a basis for flood plain management including zoning and subdivision regulations.

The analysis was initiated as a result of a meeting called by the Lancaster Town Manager and Selectmen held August 9, 1971, at the Colonel Town Community Center. Those who attended the meeting, including representatives from the U. S. Department of Agriculture Soil Conservation Service, U. S. Army Corps of Engineers, and the New Hampshire Office of Comprehensive Planning, agreed that flood plain mapping would greatly benefit the community and its flood management efforts. Field investigation was underway in September of 1971. By November of that year Lancaster was named the first New Hampshire community to become eligible to participate in the National Flood Insurance Program.

The cooperation and assistance given by the following people, agencies, and organizations throughout the study is greatly appreciated:

Donald E. Crane, Town Manager, Lancaster, New Hampshire

Selectmen, Town of Lancaster

Planning Board, Town of Lancaster

Robert W. McIntosh, Chief, Floodplain Management Services, New England Division, Corps of Engineers

William Swaine and Joseph J. Miliano, Planning Branch, New England Division, Corps of Engineers

Richard A. Brunel and Harland E. Roberts, Design Division, New Hampshire Department of Public Works & Highways

John Ross, Division Engineer, New Hampshire Department of Public Works & Highways

Donald Jacobs and Alec Nicholas, Graphic Arts Section, New Hampshire Department of Resources and Economic Development

Charles Hale, Director, Water Resources Branch, Concord Office, U. S. Geological Survey

Charles McMann and Leo Rideout, Engineering Technicians, Town of Lancaster

Bonnie Lee Studio, Lancaster, New Hampshire

Many other concerned local citizens who offered their comments regarding past flood experience.

Flood information relative to the town of Lancaster is on file and available for public inspection at the Town Manager's office. It is hoped that this information will be useful to the community in its efforts to better manage flood plain lands and reduce the local loss due to flooding.

This report has been compiled and prepared for the cooperating agencies by George W. Stevens, Hydrologist, U. S. Department of Agriculture Soil Conservation Service, and William W. Hoffman,

Principal Planner, New Hampshire Office of Comprehensive Planning.

Mary Louise Hancock
Community Planning Director

Donald G. Burbank
State Conservationist

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## SUMMARY

The Lancaster Flood Hazard Analysis was conducted by the United States Department of Agriculture, Soil Conservation Service, and the New Hampshire Office of Comprehensive Planning during the fall and spring months of 1971 and 1972. This analysis of flooding sets forth in photographs, aerial photographs, graphic profiles, and mapping, the limits of flooding in the Connecticut River, Israel River, Otter Brook, Burnside Brook, Indian Brook and Whipple Brook, all in the town of Lancaster, New Hampshire. The purpose of the analysis is to aid in the identification of local flood problems and to encourage the best utilization of flood lands through land use controls and public access to flood information. The mapping contained in this report can serve as a basis for land use development regulations.

The report is based on historical storm and flood information, available stream flow records, and other technical data defining the flood crest elevation and extent of land inundated by potential floods in the Lancaster area. The U. S. Department of Agriculture, Soil Conservation Service and the New Hampshire Office of Comprehensive Planning will provide interpretation and technical assistance in the application of the data presented herein.

## BACKGROUND

Floods can occur at almost any time of year. In late June of 1972, Hurricane Agnes wrought flooding in the eastern United States, causing the greatest loss in flood history - over seven billion dollars from Florida to New York State. New Hampshire flood history dates back to 1740 and indicates that at least 37 floods have occurred in the past 233 years during all seasons of the year. New Hampshire usually has 43 inches of precipitation annually; half of this amount normally falls as snow. The statistics however are an average; and on a yearly basis floods could easily occur due to unpredictable weather patterns.

Rivers and streams generally flood in some degree on an annual basis due to spring snow melt and rainfall. At this time of year soils are either saturated with water or partially frozen so as to prevent the absorption of additional waters generated by rain or warm melting temperatures. During other periods of the year heavy rainfall and saturated soils cause flooding. Frequently, weather patterns merge over New England, with warm moist ocean air rising over cooler air masses resulting in large amounts of precipitation.

Floods are a natural phenomenon which, along with creating great destruction, can benefit all living things. Flooding provides for the growth and renewal of living streams in many ways:

a. The fertile flood plains which support lush agricultural crops as well as native plant varieties were developed by deposition of sediment from periodic flooding.

b. Breeding habitat for animal and insect species is provided by spring pools remaining after flooding; larger creatures depend on the production of insects and other life as a food source, their food chain depends upon the existence of moist wetland habitat in the flood plain.

c. Floods carry food to ocean estuaries, the breeding grounds for marine life, an important food source for man.

The flood plain, formed by centuries of erosion, belongs to the rivers and streams themselves, yet is claimed, unpredictably, for only short periods of time. In many areas of New England and New Hampshire, man has been slow to gain respect for the flooding characteristic of riverine systems, while in other areas, open space land uses such as agriculture, recreation and scenic vistas blend with water drainage and inundation of lands. Flooding has been aggravated in many areas by development such as that associated with cities, towns and villages adjacent to water courses. Flood hazard or the potential for flood loss increases in developing or developed areas.

Historically, many of the early New England settlements were located adjacent to water. Water provided transportation, power, and an opportunity for waste disposal. Agriculture was widespread with flood plain lands being a preferred cultivation area. More recently, agriculture in the east has declined, and urban development has, in many sections, spread rapidly across the flat and deep flood plain soils.

Development and urbanization mean new homes, schools, factories and road systems. This results in less exposed soil and vegetation to absorb precipitation, producing more storm runoff. Pavement, roofs, compacted soil and storm sewers all increase the rate of runoff and therefore increase the flood hazard locally and down stream.

Flooding is also increased by land filling, structures, bridge abutments, and raised transportation systems in the flood plain area. These encroachments constrict the flow of flood water and increase flood depths in areas upstream.

The residents of a community can live in harmony with periodic flooding by sensible utilization and respect for flood plain lands. Anyone who proposes to build a structure should first refer to a flood plain map identifying areas which might be inundated. The individual then would be in a better position to make land use decisions which conform with the ecological and physical requirements of the flood plain. The community, of course, can encourage sound land use measures by adopting land use controls, such as subdivision regulations and zoning ordinances.

Certain measures are needed to cope properly with flooding in the State of New Hampshire. First, a statewide flood management program is needed to coordinate flood plain survey studies and to develop a broad program of local flood plain planning assistance. Secondly, communities must work to obtain mapping of their flood plain lands and to develop necessary land use controls to prevent the inappropriate use of flood plain. Finally, where flood plains are already developed, structural

measures (dams, dikes, water channel improvements) may be needed to prevent inundation and minimize flood losses.

The Lancaster Flood Hazard Analysis Study is the basis for reducing local flood losses. Based on this mapping, Lancaster can develop and adopt local controls to regulate flood plain development.

## A FLOOD PLAIN MANAGEMENT PROGRAM

This report contains the mapping and profiles which are basic tools for establishing a flood plain management program in Lancaster. This information provides a technical basis for arriving at solutions to minimize flood damages. Included in the exhibits of this report are aerial photographs showing flood plain limits, flood water profiles which indicate the water elevation on several rivers and streams, and photographs which show the extent of flooding likely to occur in various areas of the town. Flood hazard areas have been mapped for the Connecticut River, the Israel River, Otter Brook, Burnside Brook, Indian Brook and Whipple Brook, all within the town of Lancaster. Three probable floods are presented, two of which are designated on the aerial photographs. They are the 10-year flood, the 100-year flood, and the 500-year flood. These floods have an average occurence of one in the number of years indicated; for example, a 10-year flood on an average is equalled or exceeded once in every 10 years. Also, the 10-year flood has a 10 percent chance of being equalled or exceeded in any given year.

Flood management techniques which can be implemented using this information as a definition of the flood-prone land area limits are as follows:

1. Future land use planning. Flood plain lands must initially be defined by survey methods to determine their specific location. Then the use of flood areas should be planned in a manner which does not conflict with their characteristic of periodic inundation.

2. Flood plain zoning. This is the legal means of implementing a municipality's future land use plan. The zoning ordinance contains both a map and the text which describe the compatible uses allowed in the flood district.

3. Subdivision regulations. Development adjacent to or within flood plain lands should meet design standards to reduce flood damage.

4. Open space planning and acquisition. The development of an open space preservation program should include a priority for flood plain lands. This land adjacent to water and wetlands is highly valuable for recreation pursuits and wildlife habitat.

5. Building Codes. The architecture of buildings, sited within flood plain boundaries, should be modified to withstand flood conditions.

6. Information availability and dissemination. By identifying flood-prone lands, many unwise decisions relative to the siting of buildings, roads, and sewage fields can be prevented.

7. Flood insurance program. Definition of flood plain lands is an integral requirement for participation in the flood insurance program administered by the U. S. Department of Housing and Urban Development. To remain eligible for the sale of flood insurance, a community must ultimately adopt ordinances and regulations controlling land uses in the areas susceptible to flooding.

## DESCRIPTION OF WATERSHED

The town of Lancaster is located in Coos County in the North Country of New Hampshire. It is nestled between the Pilot Range of the White Mountain National Forest and the Connecticut River. Lancaster's 1970 population of 3,219 is the largest in over 1,500 square miles of the upper Connecticut Basin. Land use in the town is predominately forest and forage with a small area of urban development on the east edge of the Connecticut flood plain. The projected population growth rate is 0.3 percent a year.

The main water courses in Lancaster are the Israel and Connecticut Rivers. The Israel River divides the town into two nearly equal areas as it flows northwesterly to the Connecticut River. These two riverine systems along with Indian Brook, a small stream flowing parallel to the Israel within the developed area of the town, are the basis for this flood hazard analysis.

The Connecticut River has a drainage area of about 1,400 square miles as it flows southerly through the west side of Lancaster. Originating in the Connecticut Lakes region of extreme northern New Hampshire, the river flows in a southerly direction to Lake Francis. Here the river, with 170 square miles drainage area, is regulated to provide flow augmentation to downstream power generation plants. A short distance downstream the west bank of the river becomes the boundary between the States of Vermont and New Hampshire.

The drainage area above Lancaster is largely hilly or mountainous and is predominately forested. While this type of terrain often produces quick

runoff with high peaks, these characteristics are not evident by the time the flood reaches Lancaster. The largest two tributaries, the Upper Ammonoosuc River and Nulhegan River, are flat gradient rivers with large flood plains. The main river also has large flood plains in the towns of Northumberland and Lancaster. The normal water level for the reach of river within Lancaster's boundaries is controlled by the Gilman Paper Company Dam located 10 miles downstream from Lancaster at Gilman, Vermont. The flashboard crest is at elevation 833.4 feet mean sea level with the dam crest at 828.2 feet msl.

With such large amounts of natural storage, the main stem of the Connecticut within Lancaster is not "flashy." In fact, much of the flood problem within Lancaster is due to the slow build-up of water behind the valley constriction in Dalton (1 mile upstream from Gilman Dam). This flood plain storage due to natural topographic features prevents the upper Connecticut from significantly contributing to the flooding of large urban areas within the lower basin.

The third largest tributary to the Connecticut above the USGS stream gage at Dalton is the Israel River (135-square-mile watershed). This riverine system differs from the others in that it has limited amounts of natural valley storage. The watershed originates on the western slopes of the Presidential Range, dropping from Mt. Jefferson's 5,715 feet msl summit to the Connecticut River.

This typically steep gradient stream abruptly changes immediately below Main Street, Lancaster, to a flat-gradient, limited-channel-capacity river flowing through flood plain common to the Connecticut River.

The land use on the Israel watershed is about 70 percent forest, a lower percentage than the rest of the upper Connecticut Basin. The trend has been slowly toward more forested areas.

The main tributary to the Israel is Otter Brook (25-square-mile watershed). This brook with its main tributaries of Burnside and Whipple Brooks (7.3- and 8.7-square-mile watersheds, respectively) enters the Israel about 1.5 miles upstream from Main Street. The land use of the Otter watershed is somewhat less forested than the remainder of the Israel watershed. The flood plains of the Otter (as well as the Israel except in the urban center of Lancaster) are in agricultural use.

The last watershed studied was Indian Brook. This 2.2-square-mile watershed is entirely within the town limits, originating on Page Hill (1,250 feet msl) and slowly meandering through five independent swamps to the urban center of Lancaster. There the brook transitions from undefined swamp flow to a narrow brook with a wide flood plain traversed by four roads and two railroads.

The present land use of Indian Brook watershed is over 90 percent forest, a higher percentage than the rest of the Connecticut Basin.

# HISTORICAL FLOODING

## November 1927 Storm and Flood

The great storm of November 1927 originated over the Caribbean in the last days of October 1927. It was not unusually severe and did not show much action until November 1 when it started northward, reaching a point off the coast of South Carolina during the night of November 2. By the next morning the center had reached the lower end of Chesapeake Bay; however, out to the northeast an extensive area of high pressure prevented the storm from proceeding in that direction. At the same time, a high-pressure area had moved in from the northwest to a position north of New York State. Thus, the tropical storm was caught between the two cold areas of high pressure and was forced to pass over them, causing intense rainfall. The storm path was directly over western Massachusetts and Vermont. The moisture laden air was not only forced over the Berkshires and Green Mountains, whose altitudes range from 1,500 to 3,000 feet, but in addition it was thrust upward over the barrier of cold, heavy air moving down from the north. The storm was greatest and its results most destructive in Vermont and adjacent areas of New Hampshire and western Massachusetts. It produced the largest discharge ever recorded on the Israel River (Table 1).

## Storms and Floods of March 1936

During March 1936, two flood events occurred which resulted in the greatest basin-wide flooding that the Connecticut River has experienced in more than 200 years. The floods were associated with two periods of heavy rainfall on March 11-12 and March 17-18. The second was generally larger and associated with more serious flood conditions.

However, the floods were not due to the rainfall alone, but rather to a combination of factors which normally cause annual spring runoff in New Lngland. The winter's snow cover in the upper and central watershed of the Connecticut was heavier than normal as little thawing had occurred during January and February. A heavy ice cover had formed over long reaches of all streams during the extended period of below freezing weather. The temperatures became unseasonably warm on March 9 and continued so during the remainder of the month. The first storm, totalling 2-4 inches of rain over the basin and augmented by runoff from the melting snow, caused large volumes of water to pour into ice-blocked channels of all waterways, resulting in notable ice jams in many areas throughout the Basin.

Although the first flood was not an extreme event when analyzed separately, the runoff conditions it left -- saturated grounds, warm temperatures, with melting snows, filled lakes and reservoirs, high river flows -- set the stage for an unprecedented flood in the basin. The second storm was greater in intensity and rainfall than the first, especially in central and southern Vermont and New Hampshire, and all of Massachusetts. Beginning in the vicinity of Lancaster on the main river and extending throughout the entire length, all previously known flood discharges were exceeded except in that part of the Connecticut River just downstream of White River Junction, Vermont, where the peak was less than that of November 1927. At Dalton, New Hampshire, a peak discharge of 48,300 cubic feet per second (cfs) resulted in a record stage of 25.6 feet. The flood crest was 840.4 feet msl at Gilman Paper Company Dam, 1,200 feet upstream from the Dalton stream gage.

May 1972 Storm and Flood

Late winter snows followed by mild weather and 2-2½ inches of rain on May 2-5 created the largest flood in Lancaster since the spring of 1954. At Dalton, New Hampshire, a peak discharge of 32,300 cfs was measured on May 6. Agricultural damage, which could have been significant from this amount of runoff, was minor as the flood occurred prior to spring planting.

Ice Jam Flooding

Ice jams are an annual threat on the Israel River and cause considerable flooding in the commercial and industrial area of Lancaster. At least 25 significant ice jam floods have been recorded during the 85-year period from 1885 to 1970. The river is a steep, mountainous stream, but becomes relatively flat in its lower reach as it flows through Lancaster. During the winter large amounts of floating river ice (frazil ice) are constantly formed in the steeper upstream reaches and are carried downstream to the flatter reaches. In this area, frazil-ice adheres to the channel bottom and forms layers of anchor ice, reducing channel depths and transportation capabilities of the river. The cover ice, which makes its way downstream during the spring runoff or wintertime floods, is then deposited upon the anchor ice. The continuation of this process results in ice jamming, causing the river to back up, overflow its banks and inundate parts of the community. In addition, snags and obstructions encroaching upon the river channel also contribute to the jams. The ice flood of record occurred in March 1968 when the water levels exceeded the ice-free flood of 1927 by 3 feet in the developed areas of Lancaster. The cover of this report shows the effects of this flood on Main Street.

High water marks for all of the above floods are shown on the profiles in the Exhibits Section of this report.

TABLE 1

| Flood | Location | Discharge (cfs) | Elevation (ft.msl) |
|---|---|---|---|
| November 1927 | Main St., Israel | 8,840[1] | 863.5 |
| March 1936 | Main St., Israel | 6,260[1] | 862.9 |
| | Rt. 2, Highway bridge, Conn. R. | 46,500[2] | 853.2 |
| | Covered bridge, South Lancaster, Conn. R. | 48,300[3] | 849.4 |
| September 1938 | Main St., Israel | 5,340[1] | 862.9 |
| April 1950 | Main St., Israel | Ice Jam | 863.8[1] |
| March 1953 | Main St., Israel | 4/ | 861.2[1] |
| March 1968 | Rt. 3, Indian Brook | Ice Jam | 848.0 |
| | Main St., Israel | Ice Jam | 866.4 |
| | Canal St., Israel | Ice Jam | 858.0 |
| May 1972 | Rt. 3, Indian Brook | 4/ | 850.3 |
| | Rt. 2, Highway bridge, Conn. R. | 32,300[5] | 849.5 |
| | Covered bridge, South Lancaster, Conn. R. | 32,300 | 845.6 |

1/ Discharges and elevations from Corps of Engineers' Reconnaissance Report, Lancaster Dam and Reservoir, dated March 21, 1969.

2/ Discharge from SCS, Elevation from USGS Water Supply Paper 798, Floods of March 1936.

3/ Discharge at Dalton USGS stream gage and elevation from USGS Water Supply Paper 798 - Floods of March 1936.

4/ Discharge not available.

5/ Discharge at Dalton USGS stream gage, elevations surveyed by SCS.

## TECHNICAL STUDY PROCEDURES

The hydrologic and hydraulic analyses were developed from the procedures in the National Engineering Handbook of the Soil Conservation Service, Section 4, Hydrology (NEH-4), and Section 5, Hydraulics (NEH-5).

The U. S. Geological Survey maintains a stream gaging station on the Connecticut River at Dalton, New Hampshire, 10 miles downstream from Lancaster.

A study of the hydraulic and hydrologic characteristics of the Israel and Indian Brook watersheds was made by examining the geology, topography, soils, land use, channel capacity, and the climatological influences. As a result of this study, the watersheds were divided into 22 subareas and 24 routing reaches.

Hydrologic classification of the soils in the watersheds was made by the Soil Conservation Service. The U. S. Forest Service assigned present and future precipitation-runoff curve numbers to the forested lands in Indian Brook watershed using the SCS soil classifications to supplement their studies of cover condition. Information on the hydrologic condition of the forest land in the watershed was collected systematically; and measurements of litter, humus, soil type, and other hydrologic factors were recorded and analyzed.

Runoff-curve numbers for the forested lands in the Israel River watershed and for the open and miscellaneous areas in both watersheds were developed from data prepared by the local SCS field office and the SCS hydrologist. Composite runoff-curve numbers were developed for each subarea. Time of concentrations for the subareas were computed by the

stream hydraulics procedure in NEH-4. Time of travel for channelized flow was computed using Manning's formula for open channel flow.

Valley and channel cross sections were surveyed at 79 selected locations to determine valley shape, width, and other hydraulic characteristics. Vertical control was established in feet above mean sea level. Elevations of roads, bridges, culverts, and other control points were established.

Other survey data along the Israel River were obtained from topographic maps (2-foot contour interval) supplied by the New England Division, Corps of Engineers, Waltham, Massachusetts. These topographic maps were developed from the 1968 field surveys used by the Corps in preliminary designs of structural improvements for preventing ice-jam flooding.

Using data from field surveys and the topographic maps, stage-discharge relationships at 79 valley cross sections were developed by computing water-surface profiles of three flood frequencies (10-year, 100-year, and 500-year floods). The modified-step method, as developed in the SCS computer program, was used in these calculations. This program solves the head-loss due to roads and bridges using the contracted opening method for open channel flow, the orifice equation for pressure flow, and the weir equation for overtopping of road fills and embankments. In making computations, normal bridge flow conditions were assumed. No consideration was made for openings blocked by ice or other debris. Flood plain filling and other encroachments also affect the water surface profiles. Computations for this study considered only those features in the flood plain at

the time field surveys were made. Future flood plain developments and modifications will require revised water surface profile computations.

Valley and channel roughness coefficients were determined from field investigation, using values developed by the USGS in slope-area measurements as guides. The Soil Conservation Service's NEH-5, Supplement B, was also used as a guide in selecting Manning's roughness coefficients.

A discharge-frequency relationship to represent the hydrology of the Connecticut River in Lancaster was developed for the USGS stream gage at Dalton using the Log Pearson Type III distribution. The use of this distribution follows the recommendation of the Water Resources Council cited in Bulletin No. 15, A Uniform Technique for Determing Flood Flow Frequencies.

The flood frequency data on Indian Brook and the Israel River and tributaries were based on the output of the SCS Project Formulation Program, TR-20, in conjunction with Corps of Engineers regional frequency relationships developed during planning of an ice retention structure on the Israel River.

TR-20 is a technical release which describes a computer program for developing a synthetic series of flood flows for predetermined frequencies and stream reaches. Its basic steps are:

1. Flood hydrograph development for each hydrologic sub-area in a watershed based upon the sub-area's drainage area, topography (time of concentration), and rainfall infiltration

capacity (runoff curve number), coupled with a rainfall distribution of a precipitation volume from U. S. Weather Bureau Technical Paper 40.

2. Flood routing of the developed hydrographs down the watershed using the Convex method, accumulating downstream tributary hydrographs on route and outputing discharges at pre-determined stream reaches. The Convex method routing parameters characterizing natural valley storage are developed during the water surface profile analysis.

The ice-jam flood frequency on the Israel River was based on the Corps of Engineers' Reconnaissance Report, Lancaster Dam and Reservoir, dated March 21, 1969. This report indicated significant ice jam floods were about 30 percent chance events. As the flood stages are not caused by any specific meteorological pattern, it is difficult to apply a sound mathematical approach in determining a probability relationship. Thus, a conservative approach could be used with the assumption that when ice jams do occur the flood stage will be at the same elevation for all events.

## STUDY RESULTS

This study displays floodwater profiles and flood hazard areas based on existing watershed land use and cover. Floodwater profiles are plotted for the 10-year, 100-year and 500-year frequency floods. The extent of two of the selected flood events are also shown on aerial photograph mosaics. The 500-year is not shown as its aerial coverage is only slightly larger than the 100-year and thus would only complicate the display. The extent of flooding indicated between surveyed cross sections is approximate as it was developed by stereoscopic techniques.

For information about a specific location, refer to aerial mosaic to determine location of nearest surveyed section and the general use affected. Then use the plotted flood profiles to determine specific elevations. This elevation can be carried to the desired location by survey procedures.

High water marks for the 1968 flood, the highest recorded flood stage on the Israel River, are plotted on the profiles in the Exhibits Section of this report. (The 1970 ice jam flood was nearly the same.) Below Main Street, the 100-year flood profile should be used to reflect flood hazard from ice jams during any given year. Above Main Street bridge the 1968 high water mark can be projected horizontally to depict ice jam hazard. No profiles were drawn on the Israel River to specifically reflect this ice jam hazard in that they would only complicate the natural flow lines. However, ice jam flooding will continue to influence flood frequencies until the ice retention structure proposed by the Corps is built. This structure is to be located

immediately downstream from Otter Brook on the Israel River. Final designs are being prepared but no construction is planned in 1973.

Indian Brook's flood hazard for all events occurring more frequently than once in 100 years should cease once the PL-566 project planned by the SCS is installed. As this plan is in its final reveiw stages, only 100-year with and without project flood lines are exhibited in this report.

Photographs showing past floods and potential flood elevations are found in the Exhibits Section of this report.

# E X H I B I T S

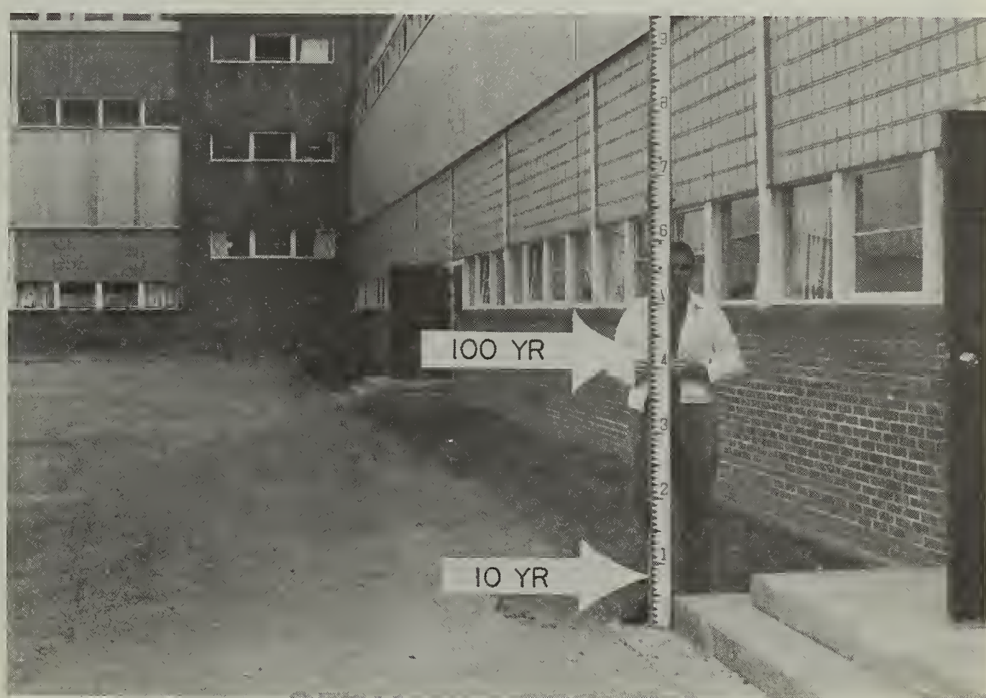
View of May 1972 flood looking southeast across Route 2 toward center of Lancaster. The water levels on Connecticut River were slightly higher than 10-year flood plotted in profiles section of this report. (Photo by Bonnie Lee Studio)


More than 2,000 feet of U. S. Route 2 will be inundated by a 100-year flood on the Connecticut River.


Main Street, Lancaster, is subject to frequent ice jam floods from Israel River. The March 1968 ice jam forced water within 1 foot of the 100-year level.


The Lancaster Water Works in the Town Hall is subject to frequent ice jam floods from the Israel River. The March 1968 ice jam came within a few inches of the 100-year level.


Two views of potential flooding from Israel River at Lancaster School. March 1968 ice jam flood was 1-2 inches over first floor of school.




Potential flooding on Depot Street from Indian Brook.


Infrequent floods on the Israel River will overtop Pleasant Street upstream from the Mechanic Street covered bridge. The flood flow will run parallel to Mechanic Street, across Main Street, along Elm and Water Streets before returning to the main channel of the Israel.

The March 1953 flood on Burnside Brook overtopped and destroyed a portion of Grange Road (section 5b on aerial mosaic sheet 6).

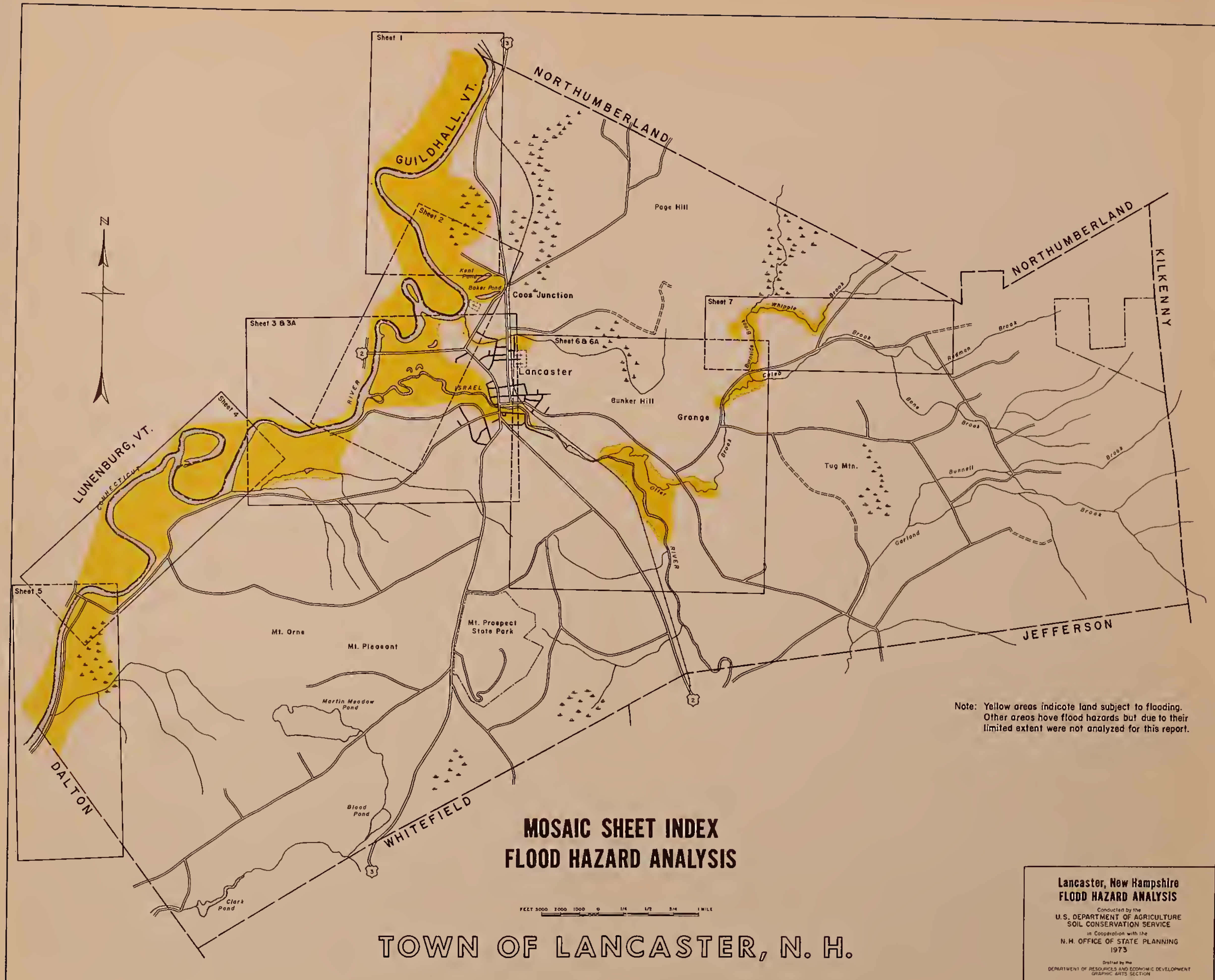

The 100-year flood level for Burnside Brook at Grange Road is higher than the March 1953 storm shown in the picture at top of page.


Potential flooding on North Road from Otter Brook.

The March 1953 flood on Otter Brook inundated a short segment of North Road (section 19 on aerial mosaic sheet 6). Note that this picture is same setting as the picture above.


Potential flooding at junction of Route 135 and access to South Lancaster covered bridge. This bridge is one of two Connecticut River crossings to Vermont within the town of Lancaster.


The main road to Dalton, New Hampshire, Route 135, is subject to several feet of water from the 100-year flood. The 10-year flood would be at road level at this location.

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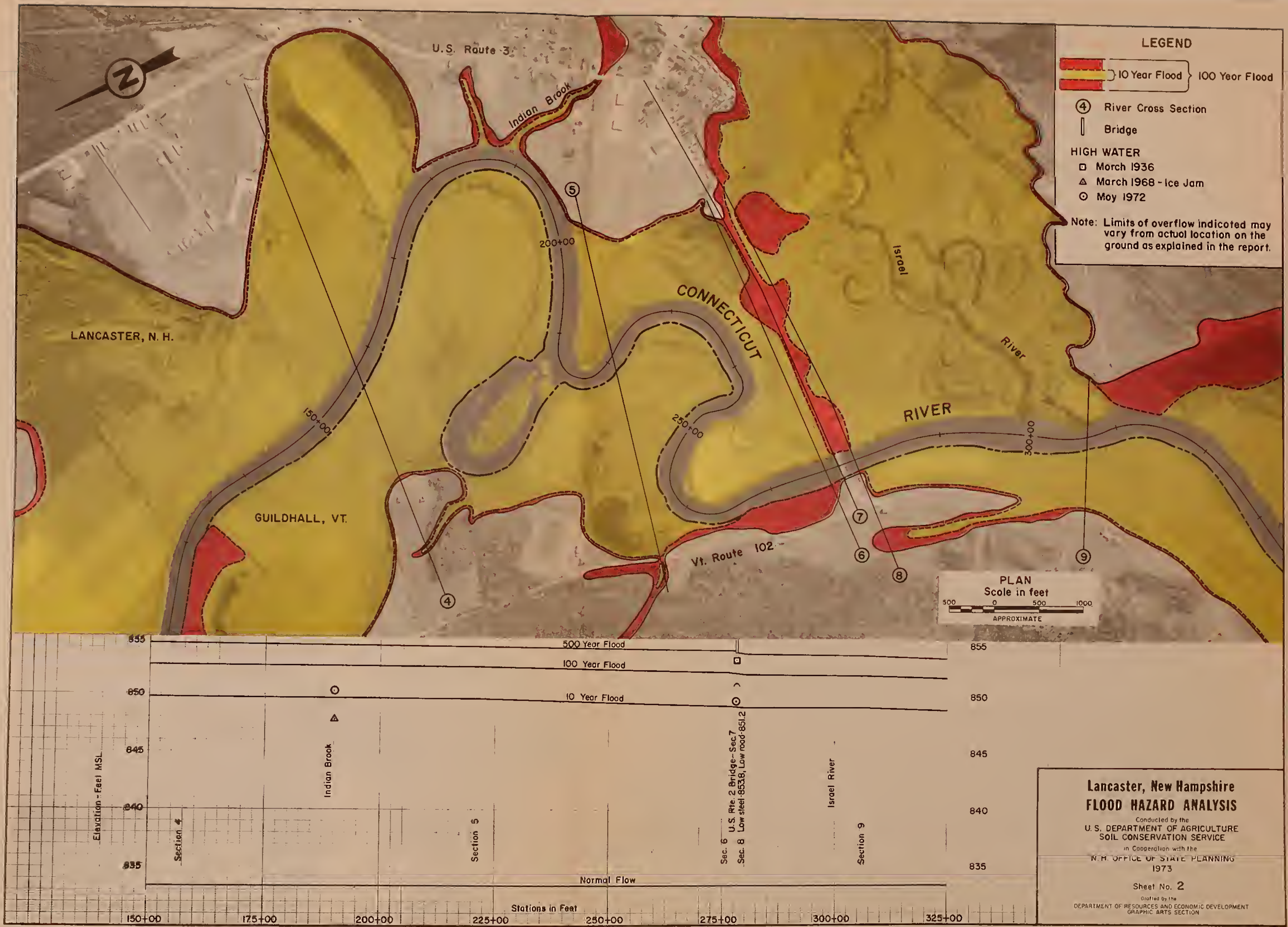


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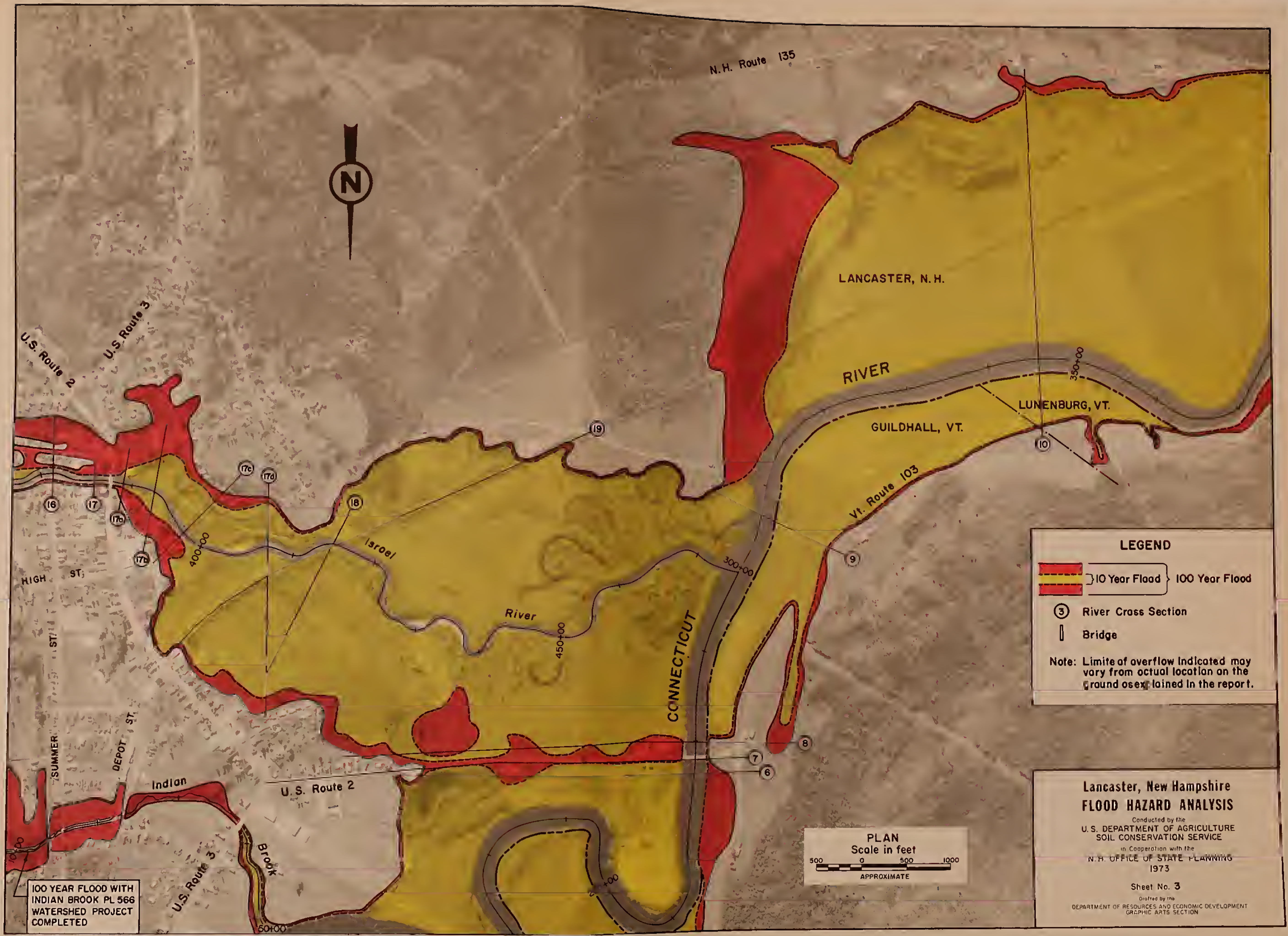
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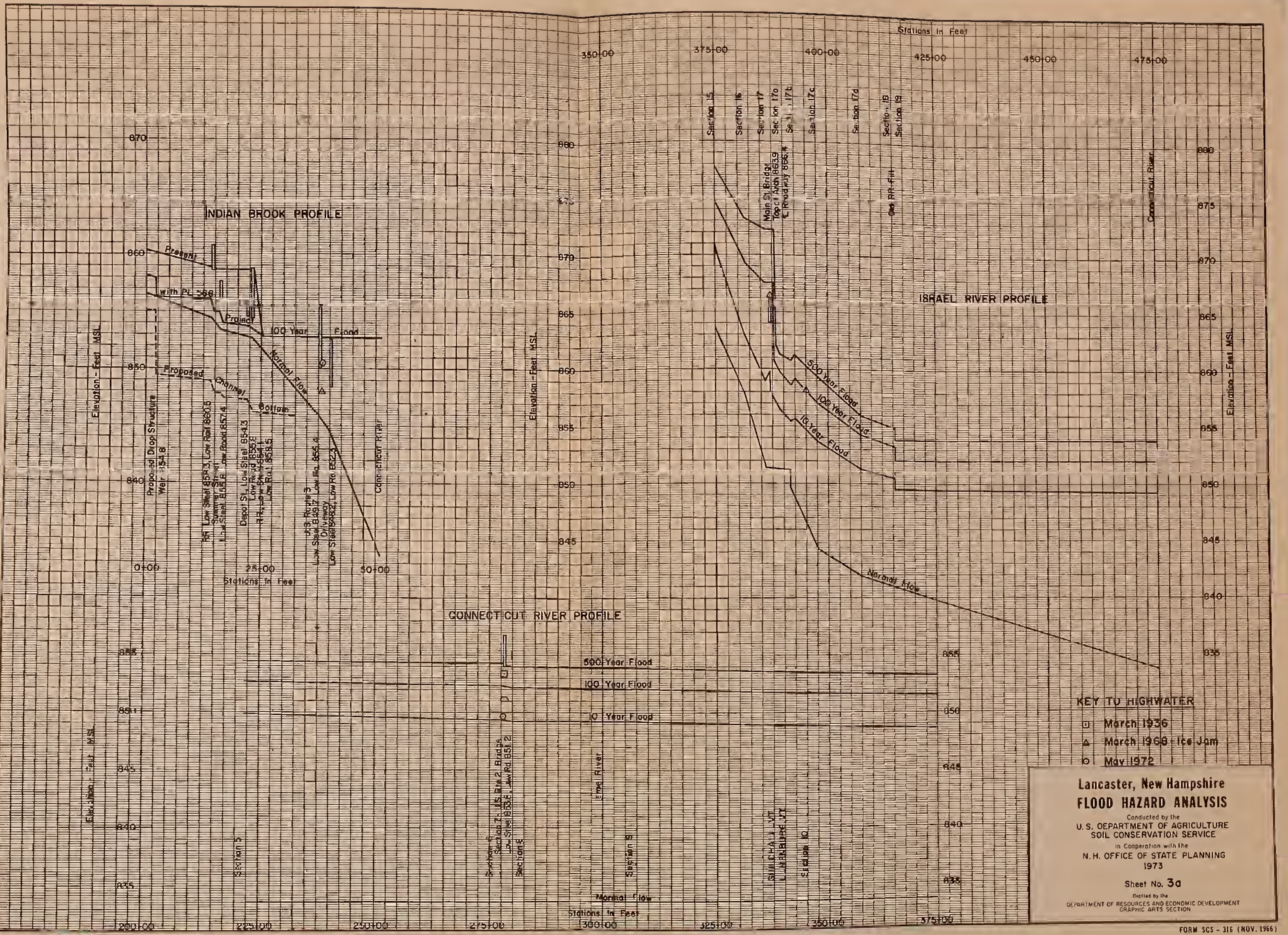
N.H. Route 135
LANCASTER, N. H.
RIVER
LUNENBURG, VT.
GUILDHALL, VT.
Vt. Route 103
U.S. Route 2
U.S. Route 3
HIGH ST.
SUMMER ST.
DEPOT ST.
Israel
River
CONNECTICUT
Indian
Brook
U. S. Route 2
U.S. Route 3
350+00
400+00
300+00
450+00
60+00
19
17c
17d
18
16
17
17a
17b
10
9
8
7
6
100 YEAR FLOOD WITH INDIAN BROOK PL 566 WATERSHED PROJECT COMPLETED
LEGEND
10 Year Flood
100 Year Flood
River Cross Section
Bridge
Note: Limits of overflow indicated may vary from actual location on the ground as explained in the report.
PLAN
Scale in feet
500 0 500 1000
APPROXIMATE
Lancaster, New Hampshire
FLOOD HAZARD ANALYSIS
Conducted by the
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
in Cooperation with the
N.H. OFFICE OF STATE PLANNING
1973
Sheet No. 3
Drafted by the
DEPARTMENT OF RESOURCES AND ECONOMIC DEVELOPMENT
GRAPHIC ARTS SECTION




**Lancaster, New Hampshire**
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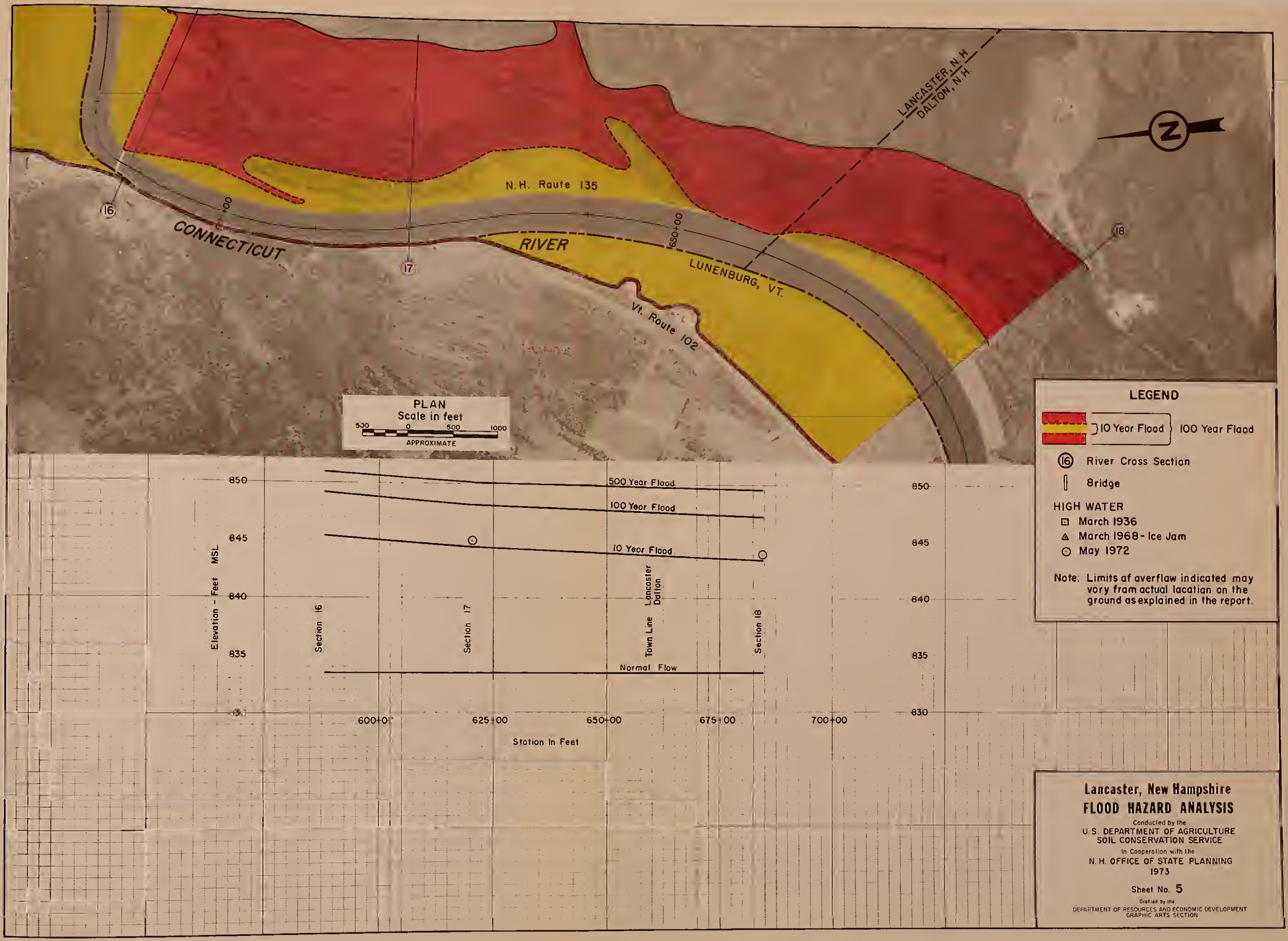
1973

Sheet No. 3a

Drafted by the
DEPARTMENT OF RESOURCES AND ECONOMIC DEVELOPMENT
GRAPHIC ARTS SECTION

FORM SCS - 316 (NOV. 1966)


Note: Limits of overflow indicated may vary from actual location on the ground as explained in the report.
N.H. Route 135
LANCASTER, N.H.
LUNENBURG, VT.
CONNECTICUT RIVER
Vt. Route 102
400+00
450+00
500+00
550+00
600+00
N
PLAN
Scale in feet
500 0 500 1000
APPROXIMATE
LEGEND
10 Year Flood
100 Year Flood
River Cross Section
Bridge
HIGH WATER
March 1936
March 1968 - Ice Jam
May 1972
500 Year Flood
100 Year Flood
10 Year Flood
Normal Flow
Elevation - Feet MSL
Section 11
Section 12
Section 13
Section 14
Sec. 15 Covered Bridge
Sec. 16
low load 846.0
low steel 849.6
350+00
375+00
400+00
425+00
450+00
475+00
500+00
525+00
550+00
575+00
600+00
Stations in feet
855
850
845
840
835
Lancaster, New Hampshire
FLOOD HAZARD ANALYSIS
Conducted by the
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
in Cooperation with the
N.H. OFFICE OF STATE PLANNING
1973
Sheet No. 4
Drafted by the
DEPARTMENT OF RESOURCES AND ECONOMIC DEVELOPMENT
GRAPHIC ARTS SECTION




**Lancaster, New Hampshire**
**FLOOD HAZARD ANALYSIS**

Conducted by the
U. S. DEPARTMENT OF AGRICULTURE
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1973

Sheet No. 5

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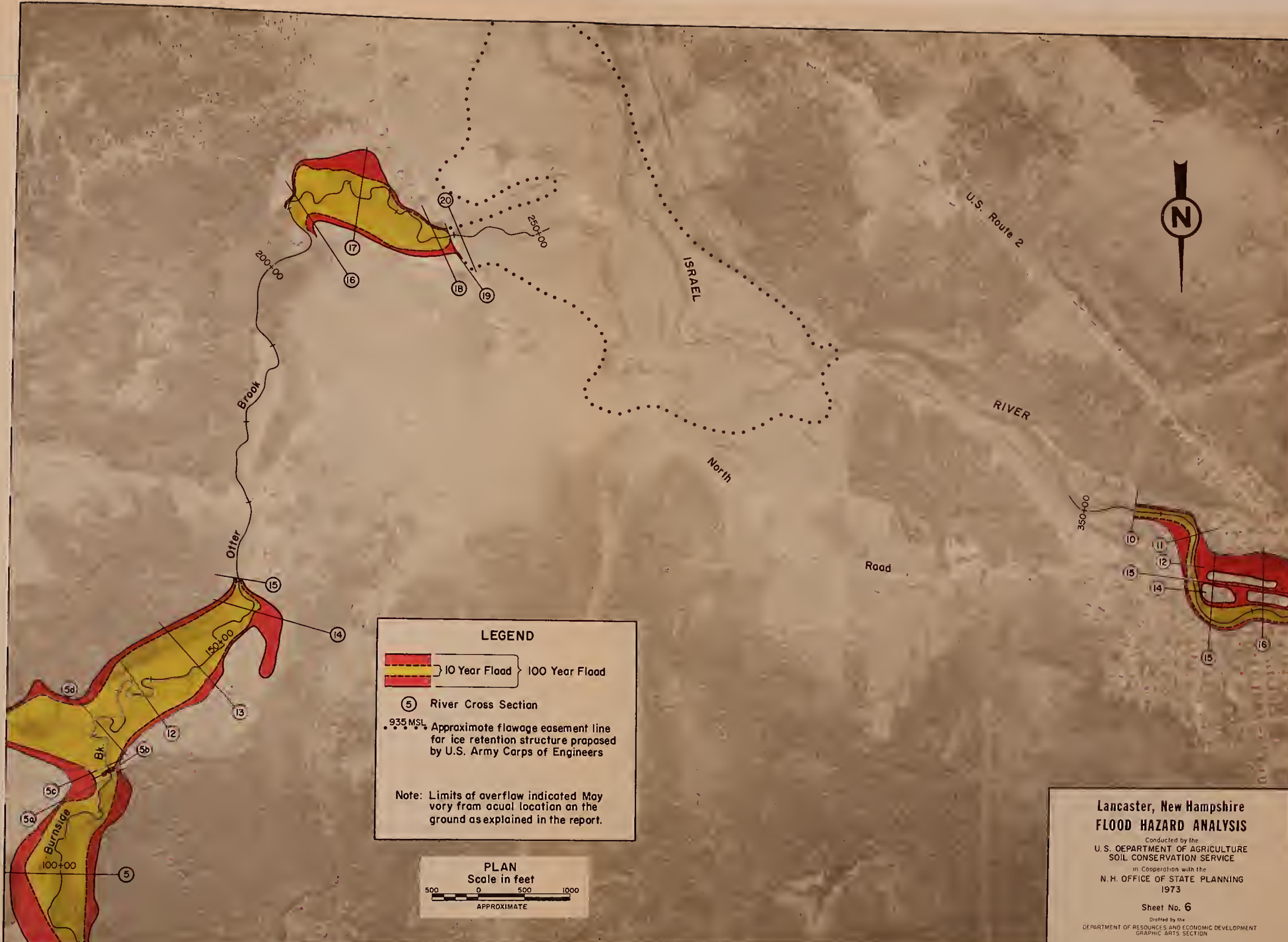
DEPARTMENT OF RESOURCES AND ECONOMIC DEVELOPMENT
GRAPHIC ARTS SECTION



LEGEND
10 Year Flood
100 Year Flood
5 River Cross Section
935 MSL Approximate flowage easement line for ice retention structure proposed by U.S. Army Corps of Engineers
Note: Limits of overflow indicated May vary from acual location on the ground as explained in the report.
PLAN
Scale in feet
500 0 500 1000
APPROXIMATE
N
U.S. Route 2
ISRAEL
RIVER
North
Road
Otter
Brook
Burnside
Bk.
100+00
150+00
200+00
250+00
350+00
Lancaster, New Hampshire
FLOOD HAZARD ANALYSIS
Conducted by the
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Sheet No. 6
Drafted by the
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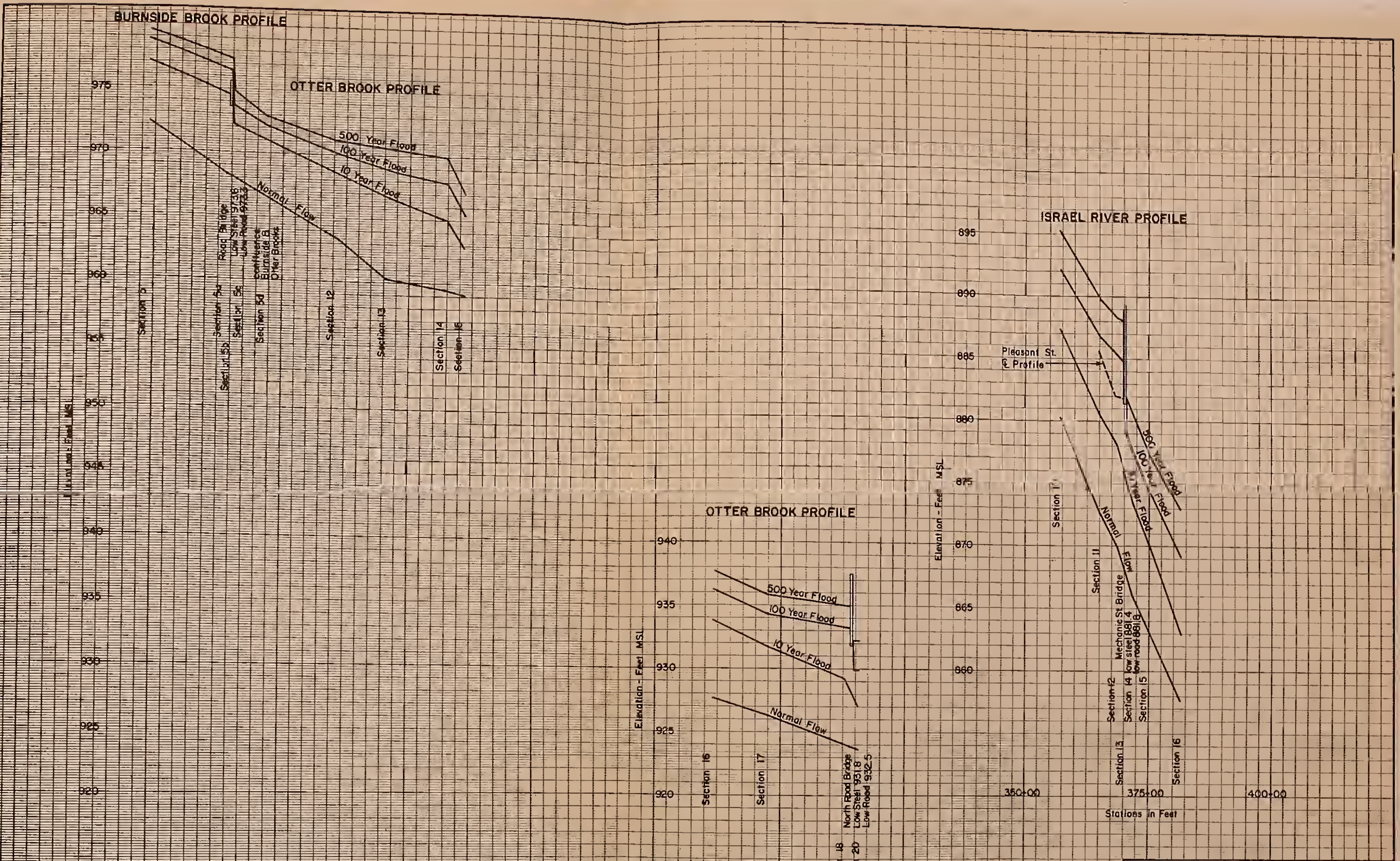
GRAPHIC ARTS SECTION




**Lancaster, New Hampshire**
**FLOOD HAZARD ANALYSIS**

Conducted by the
U. S. DEPARTMENT OF AGRICULTURE
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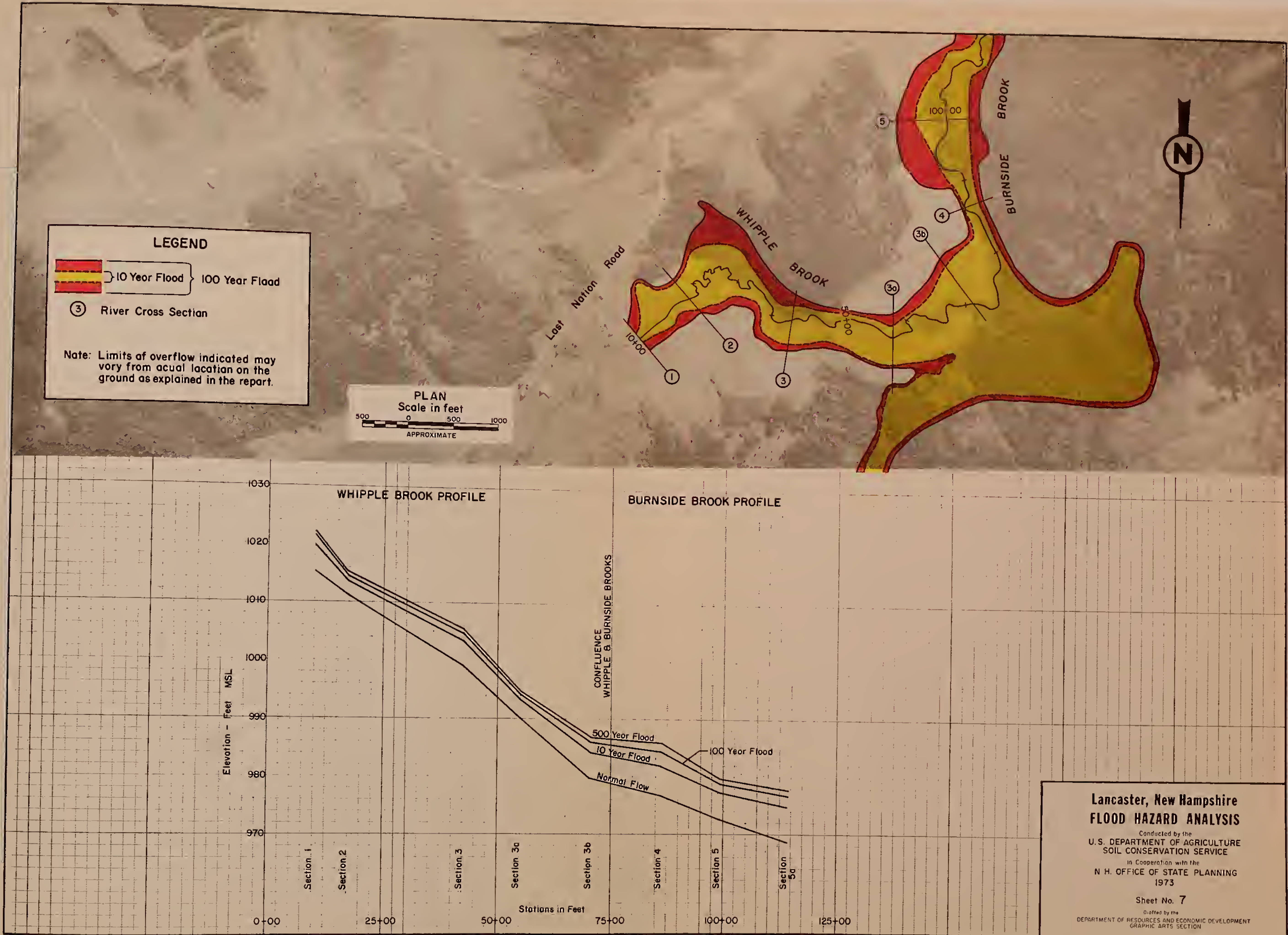
1973

Sheet No. 6a

Drafted by the
DEPARTMENT OF RESOURCES AND ECONOMIC DEVELOPMENT
GRAPHIC ARTS SECTION

FORM SCS - 316 (NOV. 1966)




**Lancaster, New Hampshire**
**FLOOD HAZARD ANALYSIS**

Conducted by the
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1973

Sheet No. 7

Drafted by the
DEPARTMENT OF RESOURCES AND ECONOMIC DEVELOPMENT
GRAPHIC ARTS SECTION

USDA-SCS-HYATTSVILLE, MD. 1973

# APPENDICES

# GUIDELINES FOR DEVELOPING LAND USE CONTROLS

## Planning and Zoning

A community can establish land use controls for flood plain lands by considering the following land use planning and zoning guidelines. The Town Planning Board would normally be responsible for these activities.

1. Develop an overall town-wide land use plan which presents proposals and policies for long-term growth. The town-wide zoning ordinance should be based on this plan and implement its various provisions and intent. In New Hampshire, flood plain zoning must be a part of a town-wide zoning ordinance and map; it cannot be adopted by itself (New Hampshire RSA Chapter 31, Zoning).

2. Obtain a flood plain map which delineates or identifies the flood lands based on the 100-year flood level.

3. Modify the mapped flood limits to recognizable boundaries which can be readily identified by physical features or surveyor's measurement. This is necessary for legal purposes and to assure that district boundary disputes will be minimized.

4. Prepare an amendment (if it is to be attached to an already existing zoning ordinance) or an ordinance section dealing with control for the flood plain zone. The text should contain provisions for the following headings:

- Finding of Facts
- Purposes and Objectives
- Establishment of Flood Plain Zoning Map
  - Rules for Interpretation of District Boundaries
  - Warning and Disclaimer of Liability
- Flood Plain District Regulations
  - Floodway-Use Standards
  - Flood-Fringe-Use Standards
- Administrative Provisions
  - Variances
  - Mapping Disputes
- Special-Use Permits
  - Procedure to be followed in passing on Special-Use Permits
  - Factors upon which Decisions are to be based
  - Conditions Attached
- Nonconforming Uses
- Definitions

The flood plain regulations contained in the zoning ordinance consist of a written text which sets forth the provisions applying to each district, together with a map showing boundaries of the various use districts.

5. Adopt the flood plain zoning amendment or zoning ordinance by holding two public hearings prior to a ballot vote at town meeting or a special town meeting (RSA, Chapter 31, Section 63a).

Land uses which are frequently mentioned as being compatible with flooding do not necessitate significant land surface change in flood plain areas. Typical uses can be summarized as follows:

- Recreational park lands
- Wildlife habitat and natural study areas
- Agricultural production
- Movable living or storage structures (trailers, parks)
- Parking fields for facilities at higher elevations

Since flood plain mapping and land use controls are somewhat technical, although obviously needed in many areas, frequent public informational meetings are suggested to explain the purposes and mechanics of flood plain management.

<u>Subdivision Regulations</u>

Subdivision regulations are another development control which complement the provisions set forth in the zoning ordinance. Subdivision regulations guide the division of large parcels of land into smaller lots for the purpose of sale or building development. Subdivision regulations are written, adopted and enforced by the local planning board.

Subdivision regulations with special reference to flood hazards often:

1. Require installation of adequate drainage facilities;
2. Require the location of flood hazard areas be shown on the plat;
3. Prohibit encroachment of floodway areas;

4. Require filling of a portion of each lot to provide a safe building site to an elevation above selected flood heights; and
5. Require the placement of streets and public utilities above a selected flood protection elevation.

In New Hampshire, subdivision regulations are adopted only after the town meeting has authorized the planning board to review and approve subdivisions. Once this authorization has been granted, the planning board prepares regulations, and holds one properly noticed public hearing. Regulations are adopted by a vote among the planning board members themselves.

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